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READING SKILL AND PERFORMANCE IN A SAMPLE OF NAVY CLASS "A" SCHOOLS

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This study sought to define the relationships between reading skill, reading requirements, and success in a sample of Navy Class "A" Schools. A further objective was to provide a methodological demonstration of the procedures required to allow an inference about causality in these relationships. Reading skill was compared with a nonverbal measure of general ability and scores on the Navy's Basic Test Battery as predictors of school success and failure. Results showed wide variation in the dependence of performance on reading

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skills among the schools, as well as the amount and difficulty of the reading they require. Reading skill and general ability were as good or better as predictors of school performance as course selector tests in some schools. A discussion of the advantages and disadvantages of several options for dealing with deficient reading is included.

FOREWORD

This research was performed under Exploratory Development Task Area ZF55-522-011 (The Assessment and Enhancement of Prerequisite Skills), Work Unit Number ZF55-522-011-03.01 (Essential Skills: Assessment, Prediction, and Remediation). The purpose of the overall task is to enhance Navy training effectiveness by improving the match between the entering abilities of trainees and the abilities presumed by their curricula. The work unit is concerned with those skills which are broadest in terms of the training for which they are prerequisite, i.e., essential skills. These include all of the basic language abilities, plus the fundamentals of computation.

Appreciation is expressed to the Commanding Officer and staffs of the Naval Training Center and Service School Command, San Diego, for providing access to the students and records.

J. J. CLARKIN
Commanding Officer

SUMMARY

Problem

The skills that a student brings to a course of instruction are among the most important factors determining his end-of-course performance. Reading skill is demanded in varying degrees by virtually all courses of instruction. Previous research has shown that the reading skills of Navy recruits vary over a wide range and that these individual differences can be used to predict attrition in recruit training. This investigation extended that work to determine the influence of entry reading skills on student performance in initial occupational training given in the Navy's Class "A" Schools.

Objectives

The objectives of this research were to examine the relationship between entry reading skill and Class "A" School performance and to demonstrate the methodological steps required to warrant an inference of causality in this relationship.

Approach

The Nelson-Denny Reading Test and an adaptation of the Raven's Progressive Matrices Test were administered to a sample of 1325 students enrolled in ten different Class "A" Schools and in three strands of the Basic Electricity and Electronics Preparatory Course. Each student's scores on the Basic Test Battery and course performance tests were also obtained. Finally, the difficulty and amount of reading assigned in each course were measured and the percentage of students in each course whose reading skills were theoretically insufficient to the requirements of the course was calculated.

Results

Wide ranges, in both reading skill and a nonverbal measure of general ability, were found within and between the schools studied. As shown below, the schools varied widely on the relationship of reading skill to course performance, as well as in the amount and difficulty of the reading assigned. It is shown how to infer the probability that course performance in a given school is causally related to entry characteristics. Additional analyses indicated that: (1) the correlation of course performance with reading skill was lower in individualized than in lock-step courses of instruction, (2) reading skill and general ability were lower among students who failed than among successful trainees, and (3) tests of reading skill and general ability show relative superiority over current course selector tests in predicting success in some schools. A comparison of the advantages and disadvantages of several options for dealing with deficient reading skills was presented.

Recommendations

1. Extend the assessment of reading skills to as many of the Navy Class "A" Schools as is practically feasible. (p. 14)

2. Improve the content validity of the reading skill assessment by substituting a test of job-related literacy for the general reading test employed in the present study. (p. 15)

3. Use a measure of course reading density which takes into account the actual time over which the assignments are expected to be read. (p. 15)

4. Expand the number of personnel characteristics measured to include others which might be mediating the correlation between reading skills and course performance. (p. 13)

5. Objectify the system for ranking courses on the extent to which the entry reading skills of their students are impeding Navy training objectives. (p. 15)

6. Develop a cost-effectiveness model for evaluating solution options when a reading ability--reading requirement mismatch is found. (p. 23)

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A complex set of interacting variables underlies successful performance in any course of instruction (Carroll, 1963). The entry characteristics of the student are among the most important of these variables. The whole system of academic aptitude testing rests on the measurement of entry characteristics to guide the selection and placement of students. Those characteristics that are clearly products of prior learning are usually called skills. Those that are not learned but appear to distinguish among people quite early in life are usually called aptitudes. The distinction is frequently made for conceptual convenience only, since most entry characteristics are products of both aptitudes and skills.

Some correlations between student entry characteristics and educational success reflect direct cause-and-effect relationships, while others reflect mediated causality. In many applied studies, it is important to determine the probability that the correlation is directly causal or mediated. For example, although the assumption of causality is fundamental in developing a prerequisite skill training program, it is not necessary in developing a procedure for screening applicants with low entry skills. In this case, a mediated relationship will suffice.

Background

The presence of gaps between reading skill and reading requirements in military training and operations has been well documented (McGoff & Harding, 1974; Carver, 1974a, 1974b; Duffy, 1976). The latter investigator reported that half of the Navy recruit population had reading skills insufficient to the reading difficulty levels of the material they were expected to master, and that the probability of failure in recruit training was predictable from, i.e., correlated with reading test scores. With this information alone, one could expect to reduce recruit attrition rates simply by placing higher literacy requirements on entry into the Naval service. However, as Duffy (1976) pointed out, such an action might be precluded, not only by the severe requirement it could create for the recruiting command, but also by the unacceptable effects of such screening on the racial and ethnic make-up of the Naval service. Further, it is unlikely that the problem could be solved either by providing remedial reading instruction or by reducing recruit reading requirements because significant recruit attrition occurs before any reading is assigned to the trainees. This correlation between reading skill and recruit attrition represents an instance in which the relationship is in part mediated by a complex set of other variables (low general intellectual aptitude, poor motivation, inability to adapt to military life, etc.), which correlate both with reading skill and with attrition. Of course, even if a substantial reading requirement had been imposed, this alone would still have left doubt about a direct causal relationship. As will be seen, the question of causality--and the consequent options for remediation--can only be assessed through the convergence of several lines of evidence.

Another investigation (Sticht, Caylor, Kern, & Fox, 1971) found significant correlations between reading ability and job performance in three Army specialist codes. However, since the jobs involved little reading, the correlation probably was not directly causal. On the other hand, the amount of reading done on the job was positively related to performance when reading skill was held constant. The more often the man engaged in reading activities, the better he performed his job--particularly in the case of poor readers. These results suggest that performance might be improved if trainees made greater use of their textual sources. It was also found that better readers made greater use of textual materials than poorer readers. If it were not for the low amount of reading reported overall, this finding would suggest that simplification of texts and even some reading training might promote increased use of textual materials and, consequently improve job performance.

One of the most direct demonstrations of a causal relation between reading skill and job performance was made in a recent study by Kulp (1974), who measured these variables in an industrial clerical task. Reading skill correlated significantly with clerical performance, and the data indicated that a gap of as little as two reading grade levels (RGLs) between reading skill and reading requirements was associated with important performance deficiencies. To increase the probability that any correlations would represent causal links, Kulp designed the clerical task such that good performance depended on accurately securing information from a written text. This action may have limited the generalizability of the findings, because, in most jobs, the required information can be obtained from sources other than the written word (by questioning or observing co-workers, for example). Nevertheless, the data are germane to those situations in which the worker must read instructions or procedures in order to perform the job.

When choosing a strategy for dealing with a deficit in a specific entry skill like reading, one should determine how closely the specific deficiency is tied to a general intellectual deficiency. This determination is critical when a remedial training strategy is being considered. General intellectual ability sets a limit on the maximum reading skill the individual can likely attain and on the minimum time he will need to attain it. If it can be shown that reading skill causally contributes to performance in a given job situation, independent of general intellectual level, then performance deficiencies are clearly more amenable to a reading training remedy. However, to demonstrate this causal contribution, one must somehow measure or estimate general intellectual level without calling on the skill of reading.

Purpose

The purposes of this study were to determine the relationship between reading skill and student performance in a sample of Navy Class "A" Schools, and to develop procedures for inferring a causal link in the observed relationships so that remedial actions could be validly recommended.

METHOD

School Sample

Ten Navy Class "A" School courses and the first three strands of the Basic Electricity and Electronics (BE&E) Course were selected for inclusion in the sample. The "A" Schools included were those for the following ratings:

1. Quartermaster (QM)
2. Interior Communications Technician (IC)
3. Electrician's Mate (EM)
4. Machinery Repairman (MR)
5. Mess Specialist (MS)
6. Data Processing Technician (DP)
7. Signalman (SM)
8. Ship's Serviceman (SH)
9. Hull Technician (HT)
10. Radioman (RM)

The BE&E Course is organized in five strands, each of which is prerequisite to and appropriate to different Class "A" Schools.[1]

Entry Tests Administered

Test instruments used in this study were the Nelson-Denny Reading Test (Form B) (Brown, 1960) and the Pattern Matching Test. The Reading Test provides (1) separate scores on vocabulary and comprehension and (2) a composite score made up of the vocabulary raw score plus two times the comprehension raw score. The scores can be converted to RGL equivalents from a table of empirical norms for the 9th to 14th grades and extrapolated norms for the 7th and 8th grades. The Pattern Matching Test is an item-analyzed version of the Raven's Progressive Matrices Test (Raven, 1958), which is widely considered to be a nonverbal measure of general intelligence.

The two tests were administered in the students' regular classrooms during the first week of instruction. Total testing time was approximately 75 minutes. Testing took place between April and July 1975, at the Service School Command, San Diego. The number of trainees tested from any one course ranged from 80 to 225.

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[1]The follow-on "A" Schools for each strand are as follows:

Strand 1 - Construction Electrician (CE), Communications Technician-Maintenance (CTM), Electronics Technician-Communications (ETN), Electronics Technician-Radar (ETR), Electronic Warfare Technician (EW), Gunner's Mate-Guns (GMG), Gunner's Mate-Missile (GMM), Sonar Technician-Surface (STG), Sonar Technician-Submarine (STS).

Strand 2 - Fire Control Technician-Gun Fire Control (FTG), Fire Control Technician-Surface Missile Fire Control (FTM), Interior Communications Technician (IC).

Strand 3 - Electrician's Mate (EM).

Strand 4 - Data Systems Technician (DS).

Strand 5 - Torpedomen's Mate (TM).

Other Personnel Measures

The following data were obtained from the records of those tested:

1. Number of school years completed.

2. Scores obtained on Navy Basic Test Battery, including the General Classification Test, the Arithmetic Reasoning Test, the Mechanical Comprehension Test, the Shop Practices Test, the Electronics Selection Test, the Coding Speed Test, and, when available, the Radio Code Aptitude Test.

3. Scores obtained on paper-and-pencil performance tests required by lock-step courses (i.e., all "A" School courses selected except that for the RM rating).

4. Number of days required to complete training in the individualized courses (i.e., the "A" School course for the RM rating and the BE&E course strands).

Course Test Measurements

Reading Difficulty

To determine whether a trainee's reading ability was adequate to the requirements of his course, it was necessary to measure the difficulty of the text assignments in that course. Many formulas are available for indexing reading difficulty. They typically involve counts of some structural elements of the text (e.g., sentence length or word length) and a regression equation relating the counts to criterion passages. The passages themselves have been scaled for difficulty by determining how quickly and well persons of known RGLs can read and understand them. The RGLs, in turn, have been derived from standardized reading tests. The regression equation provides quantitative weights for each structural element count to predict any new passage's difficulty level, expressed in RGL equivalent.

The Reading Ease (RE) formula, which was originally developed by Ruldolf Flesch (1948), uses the number of words per sentence and the number of syllables per 100-words of text as its variables. Since the weightings in the RE formula were derived using a sample of children and civilian adults reading nonmilitary texts, they were recalculated for Navy personnel and Navy texts by Kincaid, Fishburne, Rogers, and Chissom (1975), who derived the following formula:

$$RGL = 0.39\ W/S + 11.8\ s/W - 15.59$$

where: W/S = mean number of words per sentence in a 100-word sample
s/W = mean number of syllables per 100-words

Biersner (1975) applied this formula to estimate the readability of 185 Navy Rate Training Manuals (RTMs). RTMs are a major source of information required by Navy personnel for advancement in rates and are frequently used as texts in Navy schools. Thus, the revised RE formula was applied to the texts used in the selected "A" Schools and BE&E strands to estimate their reading difficulty. The formula weights for four of the courses (MR, DP, IC, SM), were taken from Biersner's report. For the other courses, because the RTMs were used little if at all, the RGLs were obtained by averaging samples from the reading material used.

Reading Density

In addition to reading difficulty, the amount of reading assigned is relevant in the kind of analysis presented here. Thus, a page count of assigned reading for each course was divided by the course length to yield the reading density; that is, the average number of pages per day assigned in each course.

RESULTS AND DISCUSSION

Trainee Sample

Although the number of trainees tested in the selected courses ranged from 80 to 225, the size of the final samples was reduced due to lack of end-of-course performance scores, etc. However, since the data losses did not appear to be systematic, the final sample, which is presented in Table 1, still can be considered representative of the school populations.

Table 1

Trainee Samples

School	Sample Size[a]
Quartermaster (QM)	97
Interior Communications Technician (IC)	77
Electrician's Mate (EM)	87
Machinery Repairman (MR)	113
Mess Specialist (MS)	163
Data Processing Technician (DP)	87
Signalman (SM)	82
Ship's Serviceman (SH)	83
Hull Technician (HT)	122
Radioman (RM)	210
Basic Electricity/Electronics (Strand 1)	113
Basic Electricity/Electronics (Strand 2)	38
Basic Electricity/Electronics (Strand 3)	53
	1325

[a]In subsequent analyses in this report, these sample sizes will vary by small amounts, due to the absence of one or another of the measures for a few trainees. In no case was the data loss large nor systematic.

Reading and General Intellectual Ability Levels

Table 2 presents the Reading Test data for the ten "A" Schools and the three BE&E strands. The schools clearly differ in the reading talent they enroll, which was predictable from the heavy weight given to the General Classification Tests (GCT) in selecting students for the various "A" Schools. Reading skill is required to obtain a high score on the GCT, as evidenced by an r of .73 between the GCT and a standardized reading test (Duffy, 1976). Table 2 shows that, although the mean reading levels of the highest and lowest scoring schools differ by only 2.4 RGLs, the proportions of low-level readers vary considerably. Only 2.3 percent of the trainees in the Data Processing Technician (DP) School read below a 10th RGL, compared to 43.4 percent of those in the Ships Serviceman's (SH) School. There is no way of knowing the full range of reading levels, because the Nelson-Denny Reading Test has norms only down to a 7th RGL. However, in three of the schools (HT, MR, and SH), about one out of six or seven trainees was reading below an 8th RGL. As indicated earlier, the importance of these differences and the method for addressing the training problems of any school with low RGL trainees depends on several factors, such as the correlation between RGL and performance, the amount and difficulty of reading required, and the extent to which any reading-skill deficits are independent of general intellectual ability.

Table 3 presents the Pattern Matching Test data for the various schools. The percentile equivalents were obtained by relating the raw scores to NAVPERSRANDCEN's unpublished norms based on a sample (N = 595) of both Navy officer and enlisted personnel. The rank-order coefficient of correlation between the mean scores on the Reading and Pattern Matching Test was .78. This indicates that schools enrolling the better readers were also enrolling the students with higher general intellectual ability. As with the reading test scores, there was a wide range of general ability test scores among the trainee samples. The three lowest scoring schools had mean scores ranging from the 25th to the 33rd percentile equivalents; and the three highest, from the 64th to the 70th percentile equivalents.

Table 2

Cumulative Percentage Distributions for
Reading Test Performance in Courses Selected

Reading Grade Level	Courses												
	DP	BE/E-2	BE/E-1	EM	IC	QM	BE/E-3	RM	SM	HT	MS	MR	SH
< 7.9	0	5.3	3.5	2.3	5.2	1.0	3.8	7.6	12.2	13.2	11.0	15.0	15.7
< 8.9	2.3	5.3	7.1	8.2	9.1	6.2	7.5	13.8	23.2	21.5	22.7	27.4	25.3
< 9.9	2.3	10.5	14.2	23.5	20.8	17.5	22.6	25.7	32.9	41.3	37.4	38.9	43.4
<10.9	9.2	18.4	21.2	32.9	32.5	36.1	34.0	44.8	54.9	55.3	57.7	56.6	59.0
<11.9	20.7	39.5	31.9	42.3	46.8	48.5	45.3	57.6	62.2	67.7	74.8	68.1	68.7
<12.9	40.2	47.4	48.7	56.4	61.0	64.9	62.3	80.0	78.0	80.1	83.4	84.1	81.9
<13.9	64.4	65.8	72.6	76.4	74.0	85.6	83.0	91.4	90.2	91.7	95.1	95.6	97.6
<14.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Mean	12.9	12.4	12.3	11.9	11.9	11.8	11.7	11.2	10.9	10.7	10.6	10.5	10.5
N	87	38	113	85	77	97	53	210	82	121	163	113	83

Table 3

Cumulative Percentage Distributions for
Pattern Matching Test Performance in Courses Selected

Pat. Matching Test %tile	Courses												
	BE/E-1	BE/E-3	DP	IC	EM	QM	BE/E-2	RM	SM	MR	HT	SH	MS
< 9.9	2	0	2	4	5	4	5	11	12	16	14	13	22
< 19.9	3	6	3	5	9	8	11	16	15	19	19	23	28
< 29.9	8	13	15	16	22	21	21	36	31	39	37	43	55
< 39.9	13	19	20	21	29	32	29	44	38	47	45	54	61
< 49.9	26	32	38	39	51	53	55	61	57	65	65	71	77
< 59.9	35	40	46	42	59	63	63	71	67	70	74	76	82
< 69.9	42	47	52	55	64	74	66	80	77	76	79	90	90
< 79.9	53	62	64	66	69	81	71	88	84	87	87	93	93
< 89.9	82	81	84	82	84	91	84	96	96	95	95	96	99
<100	100	100	100	100	100	100	100	100	100	100	100	100	100
Mean	70	65	64	59	54	49	49	38	38	34	33	29	25
N	113	53	87	77	85	97	38	210	82	113	121	83	163

Prioritizing Schools on the Importance of Reading Skill

These reading and general ability measures become more informative and useful when examined in the light of other aspects of the students and the training tasks. Table 4 presents the kinds of data minimally required to allow a causal inference about the relation between reading skill and academic performance. In the lock-step instruction courses, academic performance was measured by weekly knowledge tests; except for the HT course, where it was measured by daily tests. In the individualized courses, performance was measured by the number of days required to complete the course.

Column 1 of Table 4 presents the correlation coefficients between reading skill and academic performance. If the problem were simply to identify the courses where it would be most profitable to screen students on their reading ability following the initial screening on the selection test battery, then little more information would be required. However, if it also concerns raising the student's entry reading levels, additional data are required, such as that provided by Column 2: the correlation coefficients between reading skill and academic performance when the covariance attributable to a nonverbal measure of general ability (Pattern Matching Test Scores) has been statistically parcelled out. The utility of this partial correlation rests on the assumption that reading skill can be improved through training, but that general ability as measured on the Pattern Matching Test, cannot be readily learned. Therefore, if the correlation is substantial, even after the contributions of general ability have been removed, then the potential exists for improving academic performance by improving reading skills. However, if the partial correlation is neither significant nor substantial, then reading skill may simply be acting as a mediator of the effects of general intellectual ability, and benefits from a reading training effort are unlikely. Assuming that the Pattern Matching Test scores reflect a general aptitude for learning, they might also be used to select promising candidates for a reading training program (i.e., students with low reading scores but a high nonverbal indication of general ability).

The low correlation between the reading skills and the academic performance of students at certain schools does not necessarily mean that reading skill is unimportant to the course of instruction at those schools. It could mean, among other things, that the academic performance measures were invalid or unreliable. One way to check on that possibility, and thus assess how much importance should be attached to a low correlation between reading skill and academic performance, is to see how well other measures successfully predicted the criterion behavior. If other reasonable predictors show no correlation, then the criterion measure rather than the predictors may be suspect. However, if predictors other than reading skill show a high correlation with academic performance, then we gain confidence both in the reliability of the criterion measure and in the conclusion that entering reading level is not a determinant of academic performance.

Table 4

Factors Involved in Assessing the Contribution of Reading to Academic Success in Selected Navy Schools

	School	(1)[a] Correlation RxA[b]	(2) Partial r RxA PMT[c]	(3) Highest Correlation with A	(4) Mean RGL of trainees	(5) Mean RGL Requirement of Texts	(6) % W/Reading Deficiency	(7) Projected No. W/ Reading Deficiency	(8) Reading Density in Pages/Day
Lock-step Instruction	DP	.25*	.15	.42*	12.9	12.5	2	6	5
	EM	.45*	.39*	.56*	11.9	12.1	21	434	20
	IC	.39*	.30*	.39*	11.9	12.6	25	298	2
	QM	.49*	.40*	.56*	11.8	14.3	55	525	9
	SM	.17	.17	.17	10.9	11.5	25	155	5
	HT	.19	.17	.23	10.7	8.4	0	0	5
	MS	.44*	.40*	.44*	10.6	11.2	27	601	7
	MR	.28*	.24*	.29*	10.5	10.5	20	105	10
	SH	.19*	.19*	.26*	10.5	12.6	54	686	9
Individualized Instruction	BE/E-2	.16	.14	.36*	12.4	12.1	9	299	26
	BE/E-1	.16*	.14	.20*	12.3	12.1	17	930	30
	BE/E-3	.45*	.39*	.45*	11.7	12.1	24	579	20
	RM	.11	.09	.14*	11.2	12.9	45	1457	4

[a]These correlations are reduced by the truncated variance produced by the trainees having been preselected on tests correlated with reading.

[b]R = Reading Test Score; A = Academic Performance.

[c]PMT = Pattern Matching Test Score.

*Coefficient of correlation significantly ($p < .05$) different from zero.

In the present study, we had three other measures of trainee characteristics that could reasonably be expected to predict course performance: years of education, scores on the Pattern Matching Test, and scores on the Basic Test Battery used to screen candidates for each course. Column 3 of Table 4 presents the highest coefficient of correlation between any of these variables, including reading, and academic course performance. It can be seen that, in some courses (e.g., SM), conclusions about the low predictive power of reading test scores must be moderated by the fact that none of the other personnel variables succeeded in predicting the criterion any better. On the other hand, in the BE/E-2 strand, the course performance measure was fairly predictable, even though scores on the reading test failed to predict that measure. Ideally, one would want more than three extra measures of trainee characteristics to assess the predictability of the criterion. However, for our purpose of demonstrating the methodological approach, these three will suffice.

Causal relationships cannot be identified from correlational information alone. The last five data columns in Table 4 present information to be used in conjunction with the correlational data to identify such relationships.

Column 4 presents the mean trainee RGL for each of the courses studied. The most that can be said from these data alone is that the lower the entering RGL, the greater the <u>potential</u> that reading skill may be a performance-limiting factor. Column 5 shows the mean readability level in RGL units for the assigned reading in each course. The difference between the values in Columns 4 and 5 is an index of the disparity between the trainee's reading ability and the difficulty of the course reading materials. Parity between the two is not required, but Kulp (1974) found a clear decline in school and job performance when the reading deficiency reached two RGLs.

Column 6 shows the percentage of men in each course sample with a reading deficiency of two RGLs or greater. From a cost/benefits standpoint, we will want to know how many people this percentage represents. Column 7 presents this information, derived from data in the school requirement report for FY 1975.

Finally, since the importance of a skill deficiency rests on the extent to which the skill is called upon, Column 8 presents a measure of the reading required per day.

We can now proceed to find the courses in our sample that have relatively large numbers of men with relatively large reading deficiencies being assigned relatively large amounts of reading. Further, we can see whether the correlation of reading with course performance remains when general ability is controlled. We assert that these are the kinds of data needed (1) in ranking a set of courses on the probability that reading skill is an important student characteristic in course performance and (2) in selecting among courses of action when a reading deficiency is found. Some illustrations from among these 13 schools provide a useful exercise in how such data might be used.

For example, the DP school appears to be a low-priority candidate for any kind of reading skill manipulation. Of the schools tested, it had: (1) students with the highest reading score average, (2) next to the lowest number of trainees with a reading deficiency, (3) the third lowest reading density requirement, and (4) an insignificant correlation between reading skill and academic course success, when general individual ability was controlled.

A similar situation, although not as evident, exists for the IC, SM, and HT Schools. In the case of the IC School, the significant reading versus course performance correlation must be interpreted in the light of the very low reading requirement. This correlation could be used as a basis for selecting IC School candidates, but we would expect little pay-off from efforts directed at reading training or at reducing reading difficulty.

At the other extreme, the QM School showed: (1) a middle rank in student reading ability, (2) the highest percentage and third largest number of students with a reading deficiency, (3) the fourth highest reading density, and (4) the highest simple and partial correlations between reading and course performance. Selecting trainees on reading skill, simplifying the textual materials, and conducting job-related reading training might all be looked at for their potential use in the school. Although not as clear cut, the MR, MS, and BE&E Schools show similar properties. The BE/E-1 and BE/E-2 courses are included in this group even though the correlations of reading with course performance were not significant. In these individualized courses, the number of days required to reach the training objective is the course performance measure. Bloom (1974) has pointed out that, in much student-paced instruction, the time required to learn becomes less predictable from entry-skill measures as the training progresses. He says this because, in interrelated course content, the speed of subsequent learning is related to the achievement level in prior learning; thus, in student-paced learning rough equivalence in prior learning is usually assured. To test this hypothesis, we computed the correlation between both reading skill and Pattern Matching Test performance and time to complete earlier and later portions of the BE/E-2 course.[2] The correlations decreased from .28 to .03 for reading skill and from .20 to .01 for nonverbal Pattern Matching Test performance, confirming the hypothesis. It should also be noted that, if the better students malingered more as they progressed through the course (as has been rumored), the same declining correlations would be predicted. Our data do not allow any rigorous test for the presence of malingering. In any event, the other factors in Table 4 point so strongly toward the importance of reading skill in BE/E-1 and 2 that the absence of a correlation should be assigned less importance. We are unable to explain why the correlations for BE/E-3 are as high as they are.

We emphasize again that the data in Table 4 are meant to be only illustrative of a procedure for: (1) ranking a set of courses on the degree to which performance in each is related to entry reading ability and (2) deciding on a course of action. If a larger sample of "A" Schools had been examined, it is quite possible that the highest ranking courses in the present sample would have been lower in the larger set.

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[2]BE/E-2 was the only student-paced course for which we had measures of time to complete intermediate objectives as well as final course objectives.

Improvements can be made in these procedures that should be considered in extending this methodological illustration. First, use of a job-related reading test rather than one measuring general literacy should improve validity. Second, a measure of reading density that reflects the time over which the students are expected to read the material, rather than simply the average number of pages assigned over the number of days in the course, would increase precision. Finally, and most important, there is a need for a reasonably objective set of rules for combining and weighting the several pieces of evidence. This need becomes particularly clear when the data are contradictory.

Reading Skill, General Ability, and Performance Test Scores

In addition to paper-and-pencil knowledge tests, most Navy "A" Schools administer some sort of job performance test. We obtained performance test data on 8 of the 13 courses studied. Table 5 presents the correlation coefficients between these data and the four student entry characteristics obtained in this study. Table 6 presents the correlation between academic test scores in all 13 schools and the four entry characteristics.

Table 5

Simple and Multiple Correlation Coefficients Between Student Entry Characteristics and Performance Test Scores in Eight Class "A" Schools

	Entry Characteristics				
School	Reading Scores	Pattern Matching Test Scores	Years of Education	Course Selector Scores	Multiple R
DP	.43	.29	.10	.24	.45
EM	-.04	-.07	.27	-.01	.29
IC	.13	.27	-.15	.35	.47
SM	-.02	-.01	.12	-.06	.16
HT	-.14	.26	-.06	.18	.40
MS	.30	.17	.30	.31	.40
MR	.22	.24	-.02	.23	.30
SH	.20	.27	.30	.41	.49
Overall	.14	.17	.12	.20	.24

Table 6

Simple and Multiple Correlation Coefficients Between Student Entry Characteristics and Academic Test Scores in 13 Class "A" Schools

School	Entry Characteristics: Reading Scores	Pattern Matching Test Scores	Years of Education	Course Selectors Scores	Multiple R
DP	.28	.31	.21	.42	.47
EM	.45	.33	.19	.55	.62
IC	.38	.37	.08	.38	.49
QM	.53	.45	.40	.59	.67
SM	.17	.01	-.03	.14	.20
HT	.24	.17	.00	.24	.32
MS	.41	.24	.33	.38	.49
MR	.25	.23	.04	.24	.32
SH	.13	.03	.26	.19	.30
BE/E-1	.16	.18	.20	---	.28
BE/E-2	.00	.23	.48	.22	.60
BE/E-3	.39	.24	.16	.07	.44
RM	.12	.12	.07	.06	.26
Overall	.27	.22	.18	.27	.35

The multiple correlations show that the entry characteristics predict academic test scores better than they predict performance test scores. The overall multiple correlations indicate that the four predictors account for more than twice as much variance in the academic test scores as they do in the performance test scores (i.e., $.35^2$ vs. $.24^2$), and each individual predictor behaves similarly. This is not an uncommon finding and reflects both the greater diversity in the determinants of performance test scores, and the greater difficulty in getting reliable measures of job performance.

Note that across schools the pattern of correlation coefficients between reading test scores and academic test scores is quite different from the pattern for those between reading test scores and performance test scores. In fact, the rank orders of the correlations by school on the two course criteria themselves show no correlation. This is probably due to (1) the typically lower reliabilities of performance test scores mentioned earlier, and (2) the less standardized format and requirements of performance tests. For example, in some courses the performance test may require that procedures acquired from prior reading be recalled for use on the test, while in others the necessary procedures are provided in written form during the test. It is a reasonable prediction that performance tests requiring prior memorization would better agree with academic tests than those that do not. We simply do not know enough about the interplay of these kinds of factors to allow a clear-cut interpretation of performance test data in assessing school reading skill requirements. Until these problems are solved, it is probably best to use academic test scores in analyses of this sort, if for no other reason than that they pose less severe problems of inference in interpreting the correlational data.

Although the pattern varies widely by school, it is clear from the overall correlations that both the Reading and Pattern Matching Test scores are quite competitive with BTB classification scores as predictors of academic test scores. For the performance test scores, Pattern Matching Test performance approximates the predictive power of the current school selection tests. We recognize that since the students were classified into their schools based on the selector scores, correlations with this variable were inevitably lowered by the trucation in variance which this prior selection produced. However, the correlation of our other three predictors with the selector scores (see Appendix A) indicates that their variances were very likely curtailed also.

For those interested in reading skill and Pattern Matching Test performance for possible use in personnel classification, Appendices A and B present the intercorrelations among the measures used, plus the contributions of each to multiple-correlations with each criterion for each school.

"A" School Failure

The probability of student failure is commonly used in addition to school grades as a criterion for judging the influence of student entry characteristics. Thus, Table 7 shows the percentage of graduates and nongraduates who scored below the mean on the four entry skill measures. (The characteristics of those who failed have been excluded from the analyses that have been presented thus far, since the necessary course performance data were not available.) As shown, in all cases, the nongraduates showed a larger percentage ($p < .01$) below these means than did the graduates. Differences were largest for the selector score and Pattern Matching Test. As indicated previously, reading tests and the Pattern Matching Test were as effective as current selection test scores in predicting academic grades. However, when course failure is the criterion, Pattern Matching Test performance is the most discriminating entry characteristic, with reading skill less so. A student's reading ability relative to his classmates and to the reading difficulty of the course material discriminated about equally between graduates and nongraduates.

Table 7

Percentage of "A" School Graduates and Nongraduates Below the Mean* on Entry Skill Measures

	Nongraduates	Graduates	Difference
Below Mean Reading Ability	62.6 N=75	46.6 N=1325	11.6
Below Mean Reading Difficulty	72.0 N=75	57.2 N=1325	14.8
Below Mean Pattern Matching Test Score	65.3 N=75	40.8 N=1327	24.5
Below Mean Selector Score	71.6 N=67	51.4 N=1152	20.2

*Mean is that for each course, not overall.

Although the differences between predictors on the two reading criteria are not large, they raise a problem similar to that discussed earlier on choosing between academic and performance test scores as the criterion of school performance. That is, the conclusions from this sort of analysis can be determined by the criterion chosen. In one sense, the pass-fail criterion should be the criterion of choice. It is quite expensive in any educational situation to carry a student on the rolls, only to lose that investment later when the student drops from the course of instruction. On the other hand, since only 5 percent of our sample failed to reach a passing grade, it may be more practical to seek ways to improve the course performance of the 95 percent who do eventually pass. In individualized, self-paced instruction, attrition is predicted to drop still further, at the cost of increased time in the schools for some students. Under these circumstances, costs are more accurately reflected by time to complete the instruction than by probability of failure. Also, the external pressures of Navy schools to minimize failures always make this measure suspect of being the result of directives by the school managers. Under these circumstances, we would argue that individual differences in course performance among passing students should be preferable to failure rate as the criterion measure in analyses of this sort.

RELATED ISSUES

Complexity of School Performance

In 1963, Carroll set forth a model of school learning, which proposes that the following five major parameters underlie a student's probability of meeting the criteria of achievement:

1. Ability to Understand the Instruction--corresponds roughly to general intellectual ability and is presumed to be relatively immune to improvement through training.[3]

2. Entry Aptitudes--the range of skills and capabilities possessed by the student at entry. They range from helpful to essential for his subsequent learning, and vary from highly resistant to highly amenable to improvement through training.

3. Perserverance--the amount of time a student is willing to spend in learning. This is heavily influenced by his experiences of success and failure, and variations in the fourth parameter.

4. Quality of Instruction--the degree to which the instructional delivery is optimal for each learner.

5. Opportunity for Learning--the degree to which individual differences in time to learn are allowed for in the instructional delivery.

It is obvious that these parameters are not independent, and that the factors underlying their variation are many and little understood. Figure 1 presents the model, to which has been added our three level breakout of the Entry Aptitudes parameter.

Reading skill is shown as one of four verbal abilities making up the broad enabling skills, which are in turn one of two components making up the Entry Aptitudes parameter of the Carroll model. If we were to similarly expand and subdivide the other four parameters, it would become immediately evident how extremely complex are the determinants of school achievement.

When a researcher attempts to study any of the first level parameters, he finds that an adequate index of measurement is typically found several layers of expansion down from the factor of interest, and that, at that point, the number of interacting variables is very large and the associated chain of causation, long and complex. Under such circumstances, even very modest correlations should be given careful attention. In the light of this complexity, some of the correlation coefficients between reading and course performance reported in this study are quite respectable, particularly when we remember that students have already been selected for the courses of study on tests that have sizable correlations with reading skill.

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[3]We used scores on the Pattern Matching Test to index this parameter.

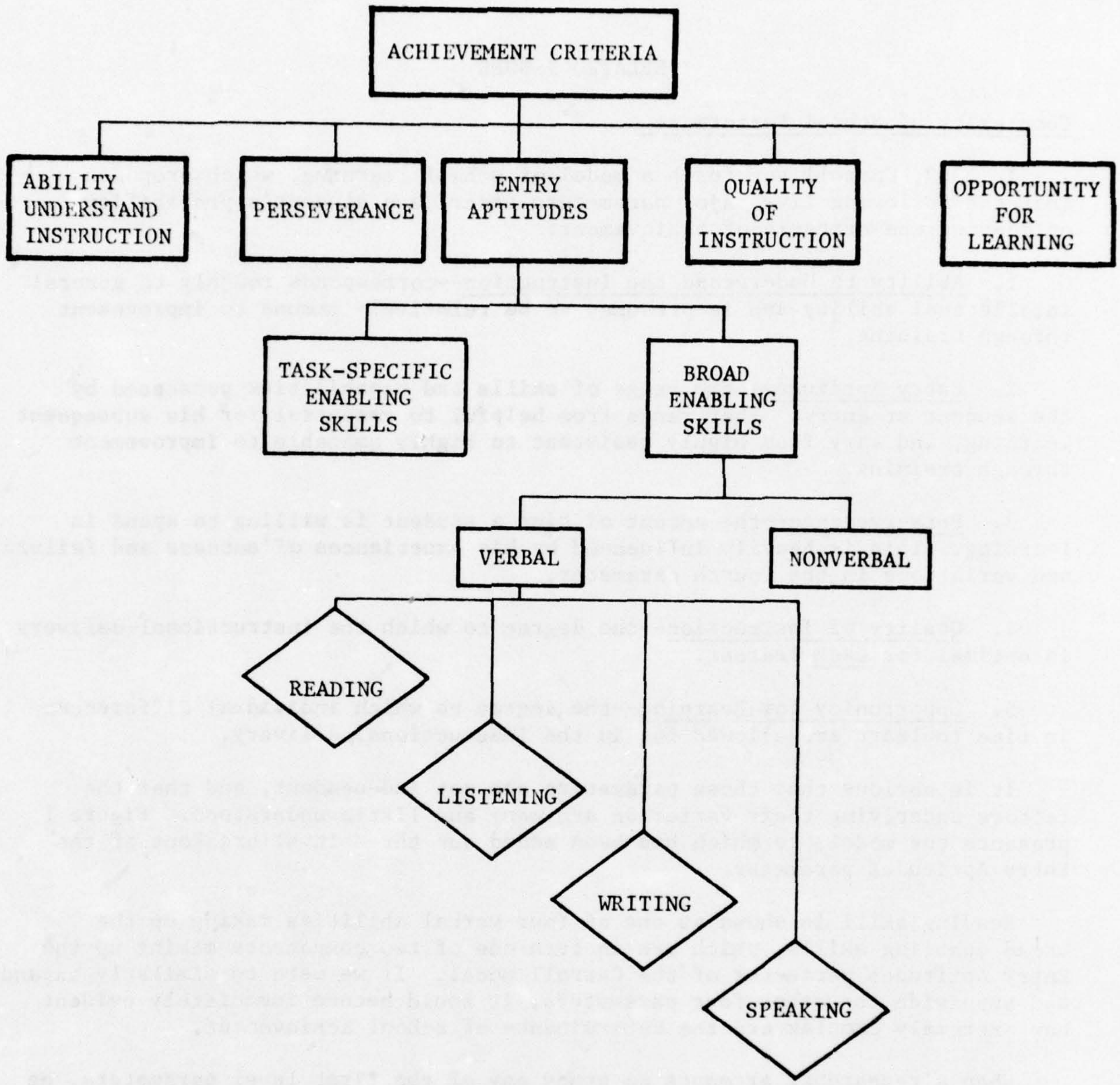

Figure 1. Reading skill in relation to course achievement: An expansion of Carroll's Model of School Learning

The goal is to locate variables among the welter of potential variables that show some probability of carrying an important amount of the variance in school achievement, and then gather the data required to decide what actions might impact that variable favorably.

We believe that the data in this report demonstrate that reading skill is an important determinant of success in many Navy "A" Schools and that, with additional information, defensible inferences about causality and the optimal mix of solutions can be made.

Choosing Among Solution Options

At several points we have alluded to the courses of action which might be taken if reading deficiencies were shown to relate strongly to course performance. We will now examine these options from the standpoint of costs and probability of success.

The Screening/Classification Option

The most direct option would simply be to make a certain level of reading skill a prerequisite for entry into each Class "A" School. This option makes no assumption about a direct causal connection between reading and performance and requires no changes in the existing training system. The impacts of this option are on other features of the personnel system. For example, if the Navy decided to screen out all those reading below an 8th RGL, this would decrease current recruiting levels by 18 percent, even in the current moderately favorable recruiting environment (Duffy, 1976).[4] Any decline in the recruiting environment and/or a requirement for mobilization would further amplify the problems in screening. Another side-effect of the screening option arises from its differential effect by racial category. Duffy's (1976) data indicate that an 8th RGL recruiting limit currently would eliminate 11 percent of the Caucasians, many of them Latin-Americans, compared to 33 percent of the Blacks. It is doubtful that any policy that would tend to produce an "all-white Navy" would be acceptable at a national level.

None of this is meant to say that screening students for reading skill should be ruled out. The very high attrition rate of the 2 percent of recruits reading at or below the 4th RGL (Duffy, 1976) makes setting a selection limit somewhere in that reading region very attractive. This report, however, is concerned with "A" School qualified personnel where basic literacy can be assumed, but where reading requirements vary widely across schools. In this situation, a reading test might be used to aid school placement. Using reading skill as a school classification measure is certainly a plausible action, providing the manpower pool is adequate to permit it and the racial/ethnic effects are acceptable. The point being made here is that attempting to deal with all of the Navy's literacy problems by raising standards requires that account be taken of the negative cross-impacts that such actions could generate in other parts of the personnel system.

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[4]In our "A" School samples, a service-wide 8th RGL screen would reduce "A" School eligibles by 8 percent overall; and a 9th RGL screen, from 15 to 25 percent.

The Job Modification Option

The reasoning behind this option says that, if literacy deficits are undermining job performance in the Fleet, then the solution is to redesign the jobs so as to reduce the need to read (means for doing this are discussed under the next two options). This action assumes a direct causal relationship underlying the correlation between reading skill and job performance. The problem with this action is that it equates reading required to do a job to the reading required to learn the job in the first instance. This is clearly not the case. Reading to learn a job makes more severe literacy demands than the reading required to do a job. We should, of course, seek to eliminate unnecessary reading tasks from Navy jobs. However, such changes might only minimally offset the reading required in Navy schools.

The Substitution Option

This option seeks to lessen the effects of a reading deficit by substituting listening. Lessons in the text might be tape recorded, for example. The assumption is that reading deficits are fairly specific to that mode of information transfer. Data presented by Sticht, Beck, Hawks, Kleiman, and James (1974) confirm that, up to about a 7th RGL, listening comprehension is superior to reading comprehension. However, above that level the evidence is that deficits in reading skill are accompanied by comparable deficits in listening skill. An adult reading at a 9th RGL will very likely show listening comprehension at about the same level. The problem, therefore, is one of a general language deficit rather than a specific deficit in reading. An additional problem is that many kinds of technical text cannot be readily adapted to the listening format (e.g., charts, graphs, tables, schematics, etc.). For the substitution option to be effective, the spoken material would additionally have to be made less complex than the written text, which brings us to the next option.

The Text Simplification Option

This option aims at eliminating reading deficiency problems by making the text comprehensible to less skilled readers. This approach has a good deal of promise and has been successfully demonstrated (e.g., Caterpillar Tractor Co., 1972). Techniques involve limiting vocabularies, avoiding synonyms, using small words and short sentences, simplifying syntax, etc. By such procedures it is often possible to reduce reading difficulty by two or even three RGLs without seriously affecting the text content. However, since it is an expensive procedure ($100.00 per page is not uncommon), its application would have to be aimed at text that is not expected to change in content too frequently. Unfortunately, change is common in technical documentation, so that the uses of this option are restricted to the more elementary level materials. The most effective use of text simplification is, of course, to ensure comprehensible writing in the first place, but this has proven so difficult a problem for the Navy to solve that a major exploratory development program has been funded to deal with it (Sulit & Fuller, 1976). Aside from cost, there is some question as to how much such procedures can simplify technical text. Such materials are difficult largely because of the presence of numerous new technical terms that, because of standardized usage, do not readily allow for simplified substitutions.

The Functional Literacy Training Option

Rather than adapting the learning materials to the learner, this approach aims at making the learner more able to adapt to the materials. The aim is to impart to the technician trainee the specific kinds of language and information processing skills demanded by the materials in his course of instruction. In this respect, it differs from traditional reading remediation programs that seek to impart general reading skills, with almost exclusive emphasis on reading text. Functional literacy training, on the other hand, provides experience in the reading tasks that the course of instruction demands (e.g., reading charts, graphs, schematics, etc.), in addition to comprehending job-relevant text. Functional literacy training is very much in vogue in the civilian sector at present and is the subject of RDT&E in all three Armed Forces. There is good reason to believe that, if reading makes an independent and a causal contribution to school success, such a training program will be effective. Just how effective depends on the length of the training and its nearness in time to the technical training. Costs would depend on whether the functional literacy training "front-ended" or paralled the technical training, whether it was conducted during or after duty hours, how many hours of instruction were required for how many students, etc.

The import of this discussion is fairly obvious. The various solution options all have something to offer in certain circumstances. The problem is to carry out a rigorous assessment and analysis to empirically justify the solution mix chosen. This report has provided a demonstration of the important features of such an assessment and analysis.

RECOMMENDATIONS

The following appear to be reasonable next steps in this research and development area:

1. Extend the assessment to as many of the Navy Class "A" Schools as is practically feasible. (p. 14)

2. Improve the content validity of the reading skill assessment by substituting a test of job-related literacy for the general reading test employed in the present study. (p. 15)

3. Use a measure of course reading density which takes into account the actual time over which the assignments are expected to be read. (p. 15)

4. Expand the number of personnel characteristics measured to include others which might be mediating the reading skill versus school performance correlations. (p. 13)

5. Objectify the system for ranking courses on the extent to which the entry reading skills of their students are impeding Navy training objectives. (p. 15)

6. Develop a cost-effectiveness model for evaluating solution options when a reading ability - reading requirement mismatch is found. (p. 23)

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APPENDIX A

INTERCORRELATION MATRICES AMONG FOUR PREDICTORS AND TWO CRITERIA OF SUCCESS IN THIRTEEN NAVY "A" SCHOOLS SEPARATELY AND OVERALL

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INTERCORRELATION MATRICES AMONG FOUR PREDICTORS AND TWO CRITERIA OF SUCCESS IN THIRTEEN NAVY "A" SCHOOLS SEPARATELY AND OVERALL

Data Processing Technician (N=75)

	(A)	(B)	(C)	(D)	(E)	(F)
Reading Skill (A)	---	.386	.410	.186	.283	.432
Nonverbal Ability (B)		---	.392	.071	.309	.294
Course Selector Score (C)			---	.325	.424	.235
Years of Education (D)				---	.214	.095
Academic Test Score (E)					---	.642
Performance Test Score (F)						---

Electrician's Mate (N=79)

	(A)	(B)	(C)	(D)	(E)	(F)
Reading Skill (A)	---	.295	.428	.165	.446	-.037
Nonverbal Ability (B)		---	.303	.065	.329	.294
Course Selector Score (C)			---	.099	.551	-.009
Years of Education (D)				---	.189	.272
Academic Test Score (E)					---	.246
Performance Test Score (F)						---

Interior Communications Technician (N=73)

	(A)	(B)	(C)	(D)	(E)	(F)
Reading Skill (A)	---	.304	.533	-.031	.378	.129
Nonverbal Ability (B)		---	.394	.131	.385	.265
Course Selector Score (C)			---	.049	.376	.352
Years of Education (D)				---	.078	-.153
Academic Test Score (E)					---	.299
Performance Test Score (F)						---

Quartermaster (N=87)[1]

	(A)	(B)	(C)	(D)	(E)
Reading Skill (A)	---	.344	.644	.246	.534
Nonverbal Ability (B)		---	.546	.232	.454
Course Selector Score (C)			---	.331	.585
Years of Education (D)				---	.399
Academic Test Score (E)					---

Signalman (N=72)[1]

	(A)	(B)	(C)	(D)	(E)	(F)
Reading Skill (A)	---	.286	.666	.227	.165	-.017
Nonverbal Ability (B)		---	.453	.015	.010	-.009
Course Selector Score (C)			---	.216	.142	-.060
Years of Education (D)				---	-.029	.124
Academic Test Score (E)					---	.109
Performance Test Score (F)						---

Hull Technician (N=48)

	(A)	(B)	(C)	(D)	(E)	(F)
Reading Skill (A)	---	.158	.415	.207	.243	-.141
Nonverbal Ability (B)		---	.307	.186	.169	.263
Course Selector Score (C)			---	.369	.238	.177
Years of Education (D)				---	.003	-.057
Academic Test Score (E)					---	.382
Performance Test Score (F)						---

Mess Specialist (N=145)

	(A)	(B)	(C)	(D)	(E)	(F)
Reading Skill (A)	---	.255	.598	.346	.407	-.017
Nonverbal Ability (B)		---	.375	.111	.237	-.009
Course Selector Score (C)			---	.288	.382	-.060
Years of Education (D)				---	.333	.124
Academic Test Score (E)					---	.510
Performance Test Score (F)						---

Machinery Repairman (N=68)

	(A)	(B)	(C)	(D)	(E)	(F)
Reading Skill (A)	---	.234	.503	.133	.247	.221
Nonverbal Ability (B)		---	.363	.045	.226	.236
Course Selector Score (C)			---	-.026	.244	.233
Years of Education (D)				---	.041	.304
Academic Test Score (E)					---	.957
Performance Test Score (F)						---

Ship's Serviceman (N=76)

	(A)	(B)	(C)	(D)	(E)	(F)
Reading Skill (A)	---	.374	.674	.244	.131	.204
Nonverbal Ability (B)		---	.495	-.015	.027	.265
Course Selector Score (C)			---	.229	.192	.407
Years of Education (D)				---	.261	.118
Academic Test Score (E)					---	.547
Performance Test Score (F)						---

Basic Electricity & Electronics-Strand 1 (N=112)[1,2,3]

	(A)	(B)	(C)	(D)
Reading Skill (A)	---	.176	.063	.157
Nonverbal Ability (B)		---	.143	.178
Years of Education (C)			---	.196
Days to Completion (D)				---

Basic Electricity & Electronics-Strand 2 (N=31)[1,3]

	(A)	(B)	(C)	(C)	(E)
Reading Skill (A)	---	.466	.758	.269	.001
Nonverbal Ability (B)		---	.428	.249	.227
Course Selector Score (C)			---	.279	.224
Years of Education (D)				---	.484
Days to Completion (E)					---

Basic Electricity & Electronics-Strand 3 (N=48)[1,3]

	(A)	(B)	(C)	(D)	(E)
Reading Skill (A)	---	.295	.492	.129	.385
Nonverbal Ability (B)		---	.270	.167	.239
Course Selector Score (C)			---	-.104	.074
Years of Education (D)				---	.161
Days to Completion (E)					---

Radioman (N=175)[1,3]

	(A)	(B)	(C)	(D)	(E)
Reading Skill (A)	---	.270	.557	.185	.274
Nonverbal Ability (B)		---	.403	.092	.222
Course Selector Score (C)			---	.168	.274
Years of Education (D)				---	.184
Days to Completion (E)					---

Overall (N=1089)

	(A)	(B)	(C)	(D)	(E)	(F)
Reading Skill (A)	---	.270	.557	.185	.274	.137[5]
Nonverbal Ability (B)		---	.403	.092	.222	.265[5]
Course Selector Score (C)			---	.168[4]	.274[4]	.202[5]
Years of Education (D)				---	.184	.174[5]
Academic Test Score (E)					---	.437[5]
Performance Test Score (F)						---

Notes:

1. These courses do not have separate performance test scores.
2. This strand has several selector scores since the students are preparing for a variety of different ratings with different basic test battery composites as selectors.
3. These are individualized courses with days to completion of the course used as the measure of academic success.
4. Based on N^s of 977.
5. Based on N^s of 544.

APPENDIX B

STEP-WISE MULTIPLE REGRESSION OF READING SKILL (R), NONVERBAL ABILITY (A), YEARS OF EDUCATION (Y), AND COURSE SELECTOR SCORES (S), ON ACADEMIC SUCCESS AND PERFORMANCE TEST SCORES

STEP-WISE MULTIPLE REGRESSION OF READING SKILL (R), NONVERBAL ABILITY (A), YEARS OF EDUCATION (Y), AND COURSE SELECTOR SCORES (S), ON ACADEMIC SUCCESS AND PERFORMANCE TEST SCORES

Data Processing Technician

Predictor	Multiple R
S	.4239
A	.4514
Y	.4610
R	.4666

Quartermaster

Predictor	Multiple R
S	.5850
Y	.6240
R	.6540
A	.6709

Electrician's Mate

Predictor	Multiple R
S	.5510
R	.5980
A	.6114
Y	.6200

Signalman

Predictor	Multiple R
R	.1650
Y	.1783
S	.1850
A	.1964

Interior Communications Technician

Predictor	Multiple R
A	.3854
R	.4663
S	.4870
Y	.4885

Hull Technician

Predictor	Multiple R
R	.2430
S	.2854
Y	.3030
A	.3203

Mess Specialist

Predictor	Multiple R
R	.4070
Y	.4560
S	.4803
A	.4892

BE/E-Strand 1[1]

Predictor	Multiple R
Y	.1964
A	.2478
R	.2759

Machinery Repairman

Predictor	Multiple R
R	.2471
A	.3016
S	.3154
Y	.3158

BE/E-Strand 2

Predictor	Multiple R
Y	.4840
R	.5022
S	.5773
A	.5972

Ship's Serviceman

Predictor	Multiple R
Y	.2607
S	.2939
A	.2973
R	.2981

BE/E-Strand 3

Predictor	Multiple R
R	.3851
S	.4073
A	.4351
Y	.4400

Radioman

Predictor	Multiple R
R	.1240
S	.1950
A	.2584
Y	.2624

Overall

Predictor	Multiple R
R	.2744
A	.3148
Y	.3401
S	.3527

Note: 1. This strand has several selector scores, since the students are preparing for a variety of different ratings with different basic test battery composites as selectors.

Data Processing Technician

Predictor	Multiple R
R	.4315
A	.4531
S	.4540
Y	.4540

Signalman

Predictor	Multiple R
Y	.1239
S	.1523
A	.1559
R	.1567

Electrician's Mate

Predictor	Multiple R
Y	.2721
A	.2846
R	.2912
S	.2915

Hull Technician

Predictor	Multiple R
A	.2434
R	.3194
S	.3712
Y	.3956

Interior Communications Technician

Predictor	Multiple R
S	.3521
Y	.3912
A	.4225
R	.4368

Mess Specialist

Predictor	Multiple R
S	.3053
Y	.3937
R	.4004
A	.4020

Machinery Repairman

Predictor	Multiple R
S	.2585
A	.3024
R	.3183
Y	.3203

Ship's Serviceman

Predictor	Multiple R
S	.4074
Y	.4616
R	.4778
A	.4922

Overall

Predictor	Multiple R
S	.2047
A	.2276
Y	.2423
R	.2425

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